RFID Technology for Pervasive, Ubiquitous Computing in the Life-Cycle of Construction Projects

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Outline

- Introduction
- Technology Description
- Suitable Construction Applications
- Pilot Tests
- RFID's role in Life-Cycle Management
- Conclusions

Introduction: Project Goals

- Investigate RFID potential to enhance construction operations
  - reduce cost
  - reduce cycle time
- Provide RFID suppliers with information regarding construction industry needs

Introduction: Approach

- Determine capabilities, current applications, benefits, limitations, and costs
- Identify potential construction applications
- Pilot RFID applications in a construction and maintenance and operations environment

What is RFID?

- RFID technology involves the use of tags or transponders that can collect data and manage it in a portable, changeable database
- “High tech” bar code label

What are its Components?

- Tags or transponders
- Reader (usually includes antenna and scanner)

RFID Tags

- Integrated circuit chip and antenna
- Encapsulated to protect against shock, fluids, dust, dirt, or other contaminants
- Different shapes and sizes

Sample RFID Tags

RFID Tag Characteristics

	Active	Passive
• Power Source	Battery	Magnetic Field
• Read Range	5 to 100 ft	Inches up to ~ 3 feet
• Lifetime	3 to 10 years	Unlimited lifetime

RFID Tag Read-Write Capabilities

	Read-Write	Read-Only
• Memory capacity	64 to 32,768 bits	8 to 128 bits
• Information content	Can be altered	Cannot be altered
• Data transfer speed	~ 3,000 bits/second	~ 8,000 bits/second

Reader

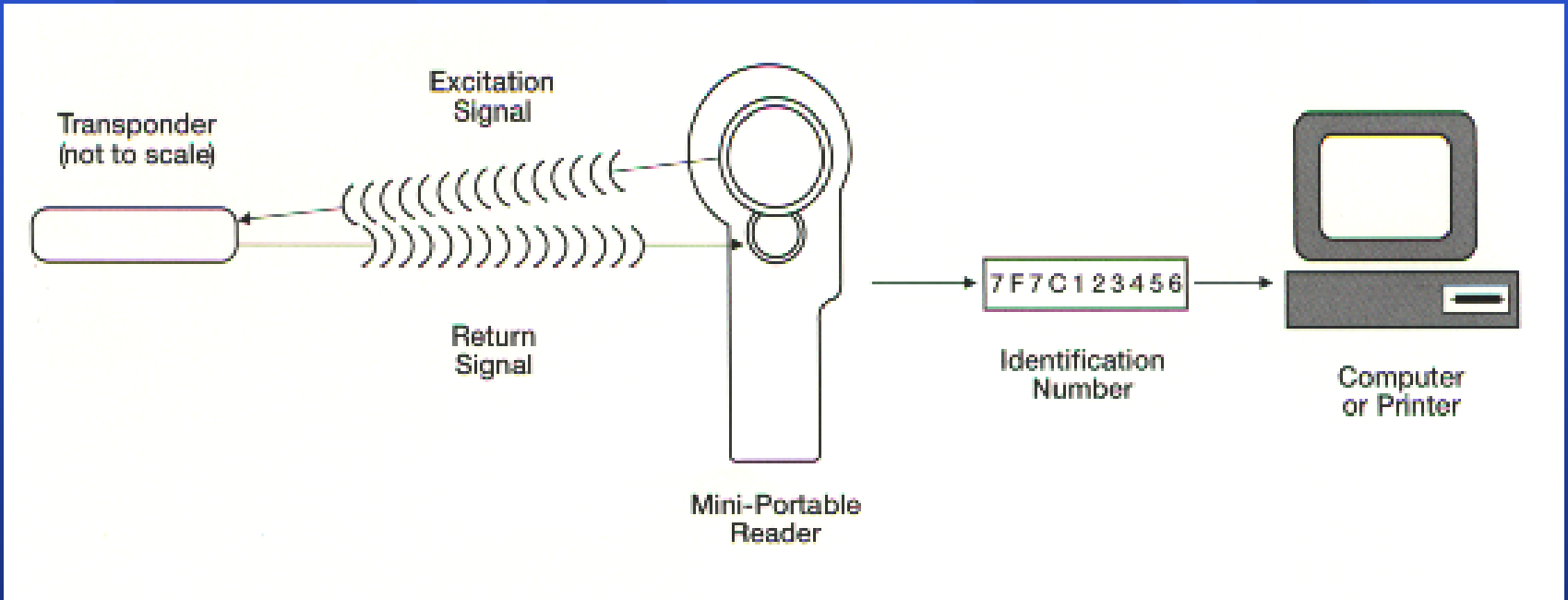
- Transmits electromagnetic field that activates tag
- Receives information transmitted by tag
- Monitors incoming transponder signals to assure valid tag data

Readers

Trovan Hand-held Reader

Hughes Mini-Portable Reader

Schematic



Schematic of Hughes Dual-Coil Technology

Benefits

- Operates in dirty, oily, wet, or harsh environments
- Functions in non line-of-sight operations without requiring contact or an unobstructed view
- Fast and highly accurate
- Difficult to copy code

Costs

Item	Price Range
• Tags	
Active (each)	up to $ 250
Passive (each)	$ 1.00 – 150
• Readers (includes Scanner and antenna)	$200 – 10,000
• Software development	$ 100 - $10,000

Limitations

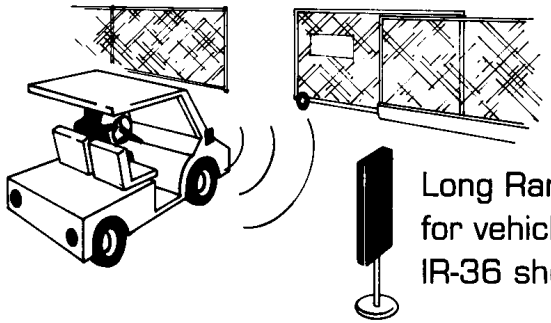
- Closed systems
  - one manufacturer's reader cannot read a tag made by another manufacturer
- Metal hampers RF tag operation by blocking and canceling the signal
- Potential interference from other RF systems
- Batteries wear out on active systems

Sample Applications

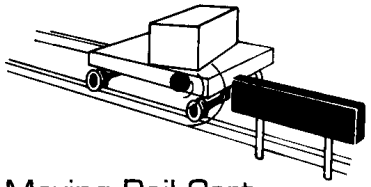
- Tolls and Fees (Ez-Pass)
- Vehicle Access (parking structures, gate control)
- Personnel identification (badges)
- Asset tracking (maintenance, gas cylinders, fleet management)
- Livestock/animal control (animal identification)

Fleet Management (Amtech)

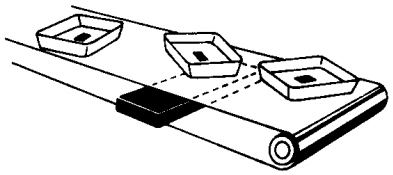
Applications (Indala)



Long Range Gate Control for vehicles (IB-11 and IR-36 shown)



Moving Rail Cart
(IT-34 and IR-24 shown)



Conveyor with randomly oriented tote boxes
(IT-21 and IR-24 shown)

Potential Construction Applications

- Conducted Workshop
  - 31 people attended including construction, owner, and RFID supplier companies
  - information exchange (RF tagging technology capabilities and limitations)
  - Discussed concerns and potential applications

Key Points from Workshop

- Technology has its strengths and limitations for Construction
  - Strengths: data storage, non line-of-sight reading, operates in harsh environments, high reliability (low error rate), rapid data transfer rate
  - Limitations: lack of standardization, passive tags require close read range, metal interferes with signal, higher costs compared to bar codes

Key Points from Workshop

- Few OEMs specialize in applying RFID to construction industry processes
- Both bar code labels and RFID tags should be considered complimentary technologies

Pilot Tests

- Contractor Perspective
  - Material receipt of pipe hangers/supports
- Owner Perspective
  - Installation of “smart instruments”
  - Maintenance of pressure relief valves
  - Operator rounds
  - Steel component tracking

Contractor Pilot

- Pipe Supports/hangers received using RFID on two Bechtel projects (Red Hills and Exxon Baytown)
- Comparison made between manual “kick and count” and RFID approach

Equipment Overview

- Telxon(R) Handheld Computer
- RFID Reader by SAT
- RFID Tags

Radio Frequency ID

Technology Overview

- RFID tag/chip emits radio frequency
  - *no line of sight* required (not a "visual" technology like barcoding)
  - *readable and writable* - store data back to the chip

RFID Tag

- SafeTracRfidOEMView

File Edit View Help

Field Name	Value	Loc...	Comment
oPurchaseOr...	23803-001-PH06-...	No	
oReleaseNu...	50	No	
oReqNumber	10-PHI-BM-G0001	No	
oMarkNumber	11-PH-BM-G015	No	
oClientNumber	3	No	
oJobNumber	54124	No	
oItemNumber	3	No	
oOrderedQua...	1	No	
oStorageLoc...		No	
oQuantityRec...	0	No	
oDamage?	no	No	

To read a tag select the menu item 'Read Tag' on the 'F

RFID Pilot Test Summary

Pipe Supports/Hangers Receipt

- Step 1: **Encode and Affix** RFID Tags (Piping Technology & Products)
- Step 2: **Receipt** into Laydown Yard
- Step 3: **Detailed Receipt** using RFID+Handheld Reader
- Step 4: **Import** Receivings File into Material Tracking System

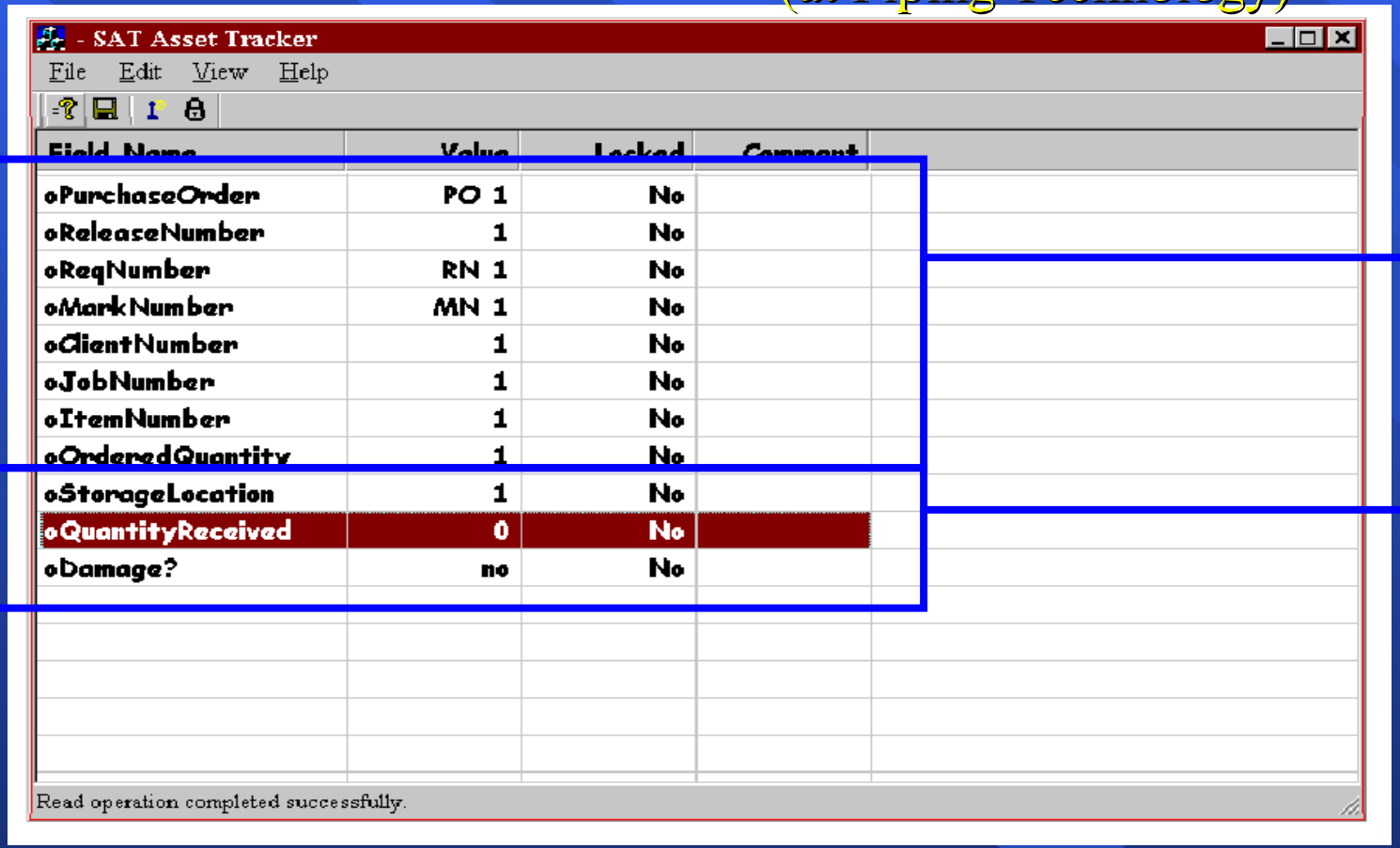
Step 1: Encode and Affix

(at Piping Technology)

- Several fields are encoded on RFID tags
- Fields are chosen to uniquely identify the pipe support
  - a) in Piping Technology's system (job number and item number) and
  - b) in customer's system (PO#, mark #)

Step 1: Encode and Affix

(at Piping Technology)



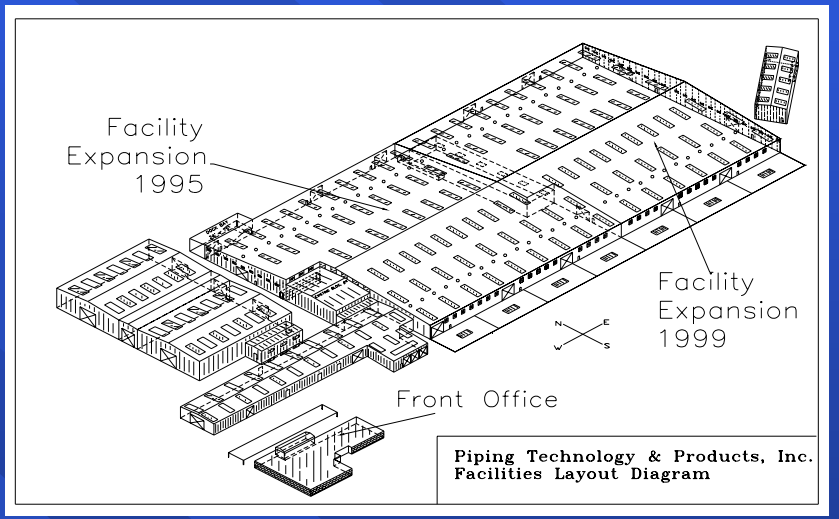
Read Only Fields

Read/Write Fields
(set by the field)

List of fields encoded

Step 1: Encode and Affix

(at Piping Technology)



Material at PT&P's plant layed out for shipping

Step 1: Encode and Affix

(at Piping Technology)

RFID Tag is affixed prior to shipment

Step 2: Receipt into laydown yard

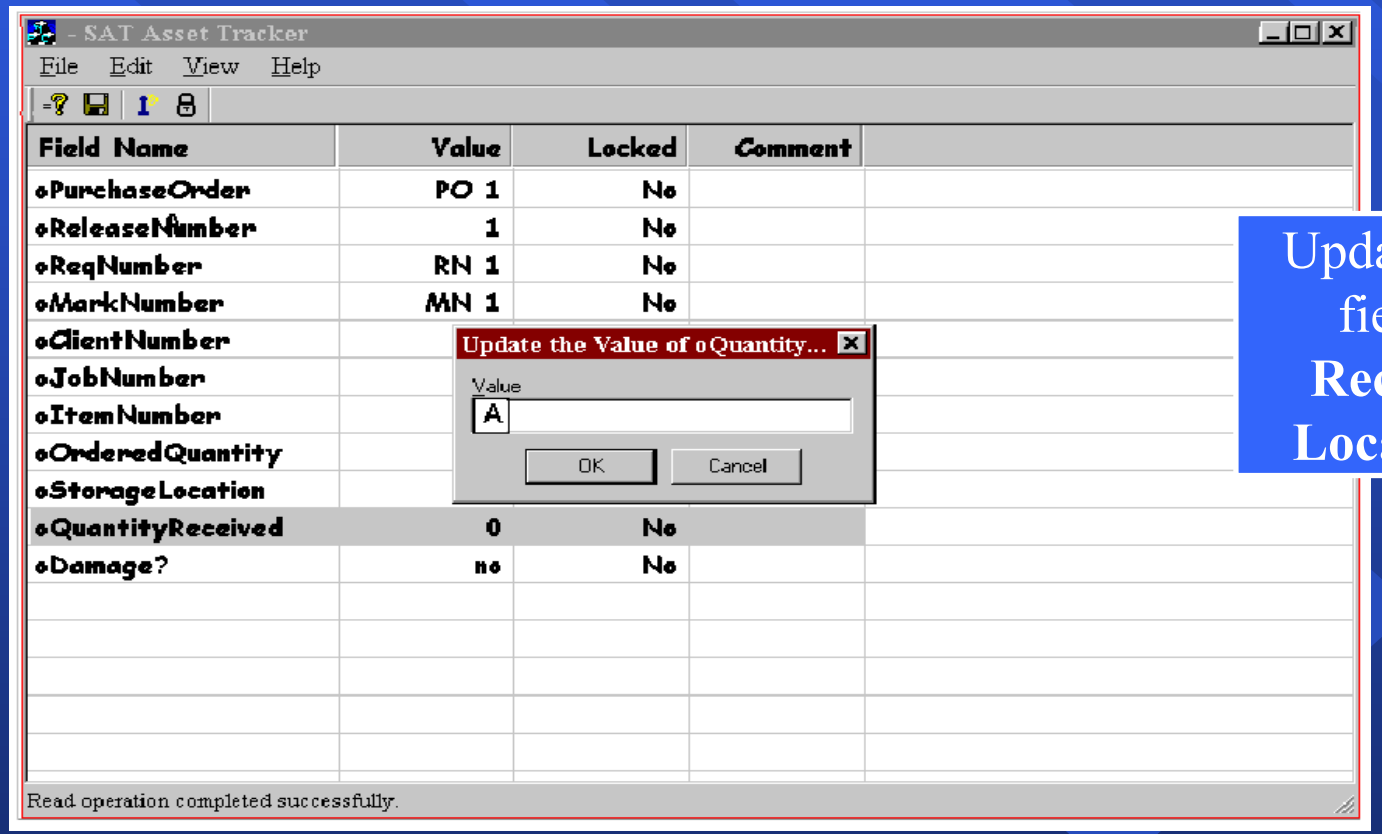
Step 2: Receipt into laydown yard

Step 3: Detailed Receivings Using RFID + Handheld

Step 3: Detailed Receivings Using RFID + Handheld

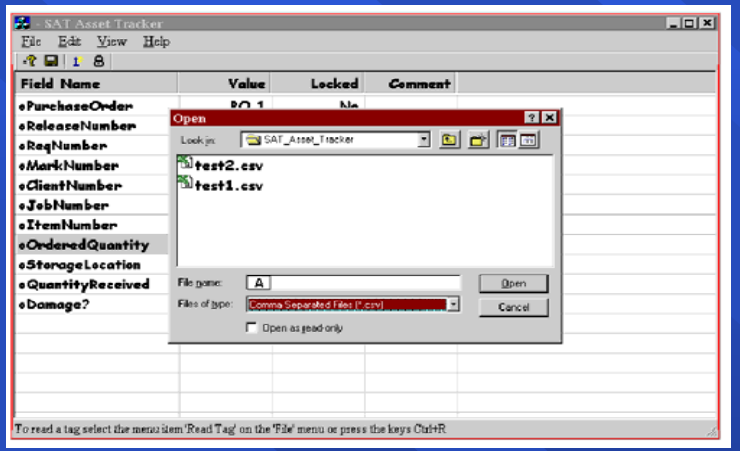
Step 3: Detailed Receivings Using RFID + Handheld

Step 3: Detailed Receivings Using RFID + Handheld



Update the read/write fields: **Quantity Received, Storage Location, Damage?**

Step 4: Import Receivings File into Material Tracking System



Microsoft Excel

Simple CSV File w/ all receivings data

Material Tracking System:

- **Bechtel**'s PTS (Procurement Tracking System)
- **Stone and Webster**'s Atlas System

Red Hills Pilot Results: Engineered Items

- RFID Strengths
  - Time savings
  - Workers liked technology
  - “Flag” written to tag indicated received item
  - No double entry
- RFID Limitations
  - Metal interferes with reader
  - A lot of bending down to read and write to tag
  - Sun glare made it difficult to see reader screen

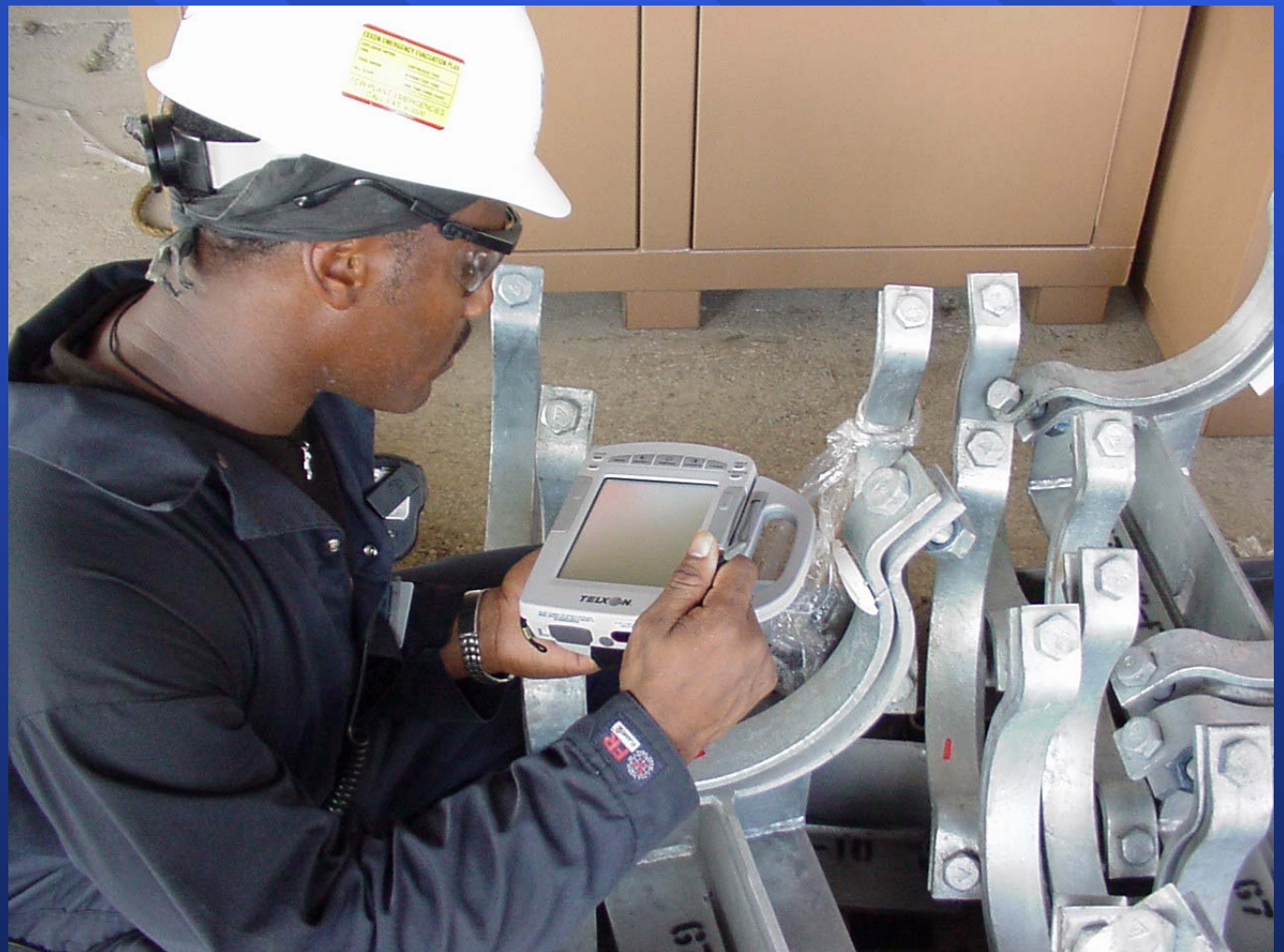
Red Hills Pilot: Time Study

Method	Manual	RFID
Time required to unload 100 hangers (minutes)	107	107
Time required to verify 100 hangers (minutes)	356 (2 people)	242 (1 person)
Time required to enter 100 hangers into PTS (minutes)	52	20 (estimated)
Total time required (minutes)	515	369

Baytown Pilot

- Differed from Red Hills Pilot

Baytown Pilot



Baytown Pilot Results: Bulk Items

- RFID Strengths
  - Time savings from downloading data
  - Tags can be reused for bulks as they are not tracked throughout the project life-cycle
  - Workers liked technology
  - “Flag” written to tag indicated received item
- RFID Limitations
  - Current test design was not ideal for bulk items
  - Metal interferes with reader

Pilot Summary

- RFID worthwhile pursuing
- Enhancements required
  - Increase read range (at least 12 inches)
  - Need an open system

RFID'S Role in Life-Cycle Management

OBJECTIVE

Investigate ways to integrate RFID technology throughout the project life cycle to improve:

- Productivity
- Cost
- Schedule
- Quality
- Safety Performance

RFID and FIAPP

Construction

- Personnel Accountability
- Safety
- Rigging Equipment
- Prevent. Maintenance
- Fleet Management
- Measuring & Test Equipment
- Quality

Facility Mgmt

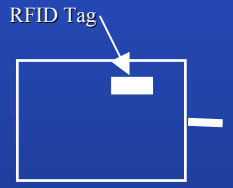
- Asset Management

MATERIALS/ASSET MGMT: Engineered Equipment Items

Construction

Owner

Motor Attributes



ID Number
Serial Number
Manufacturer's Date
Unit Cost
Windings
RPM
Preventative Maintenance (e.g., change oil, lubrication, schedules)

RF Link

Asset Management Capital Equipment Program Database

Conclusions

- RFID is a proven technology
- Significant potential for both owners and contractors